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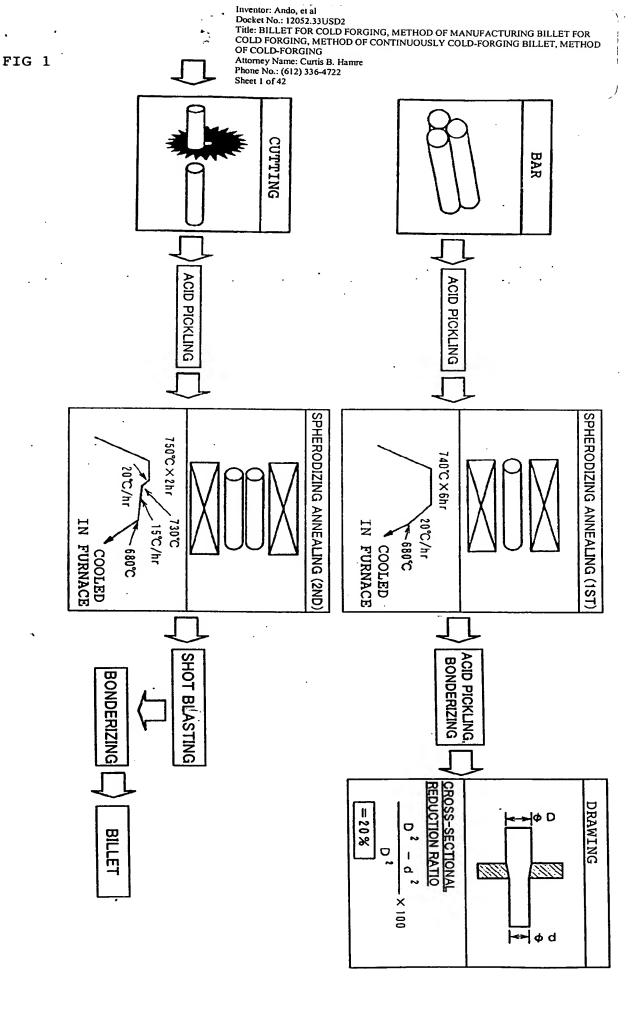
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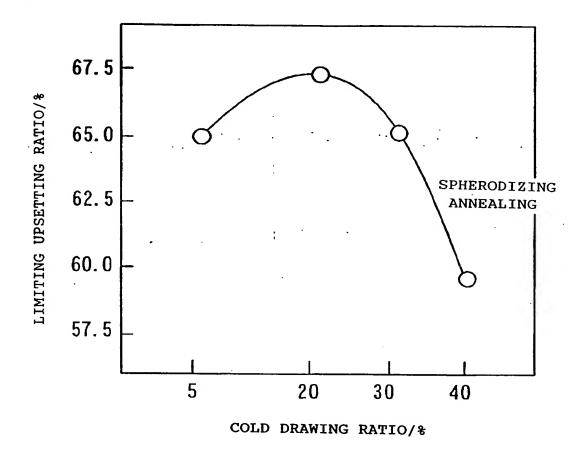
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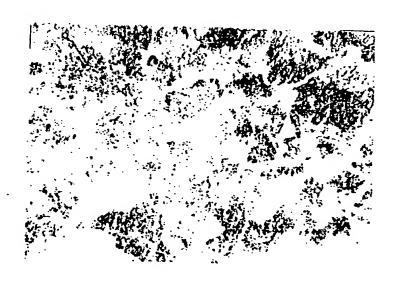
FIG. 2



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FIG. 3





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FIG. 4

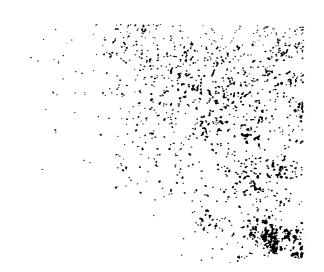




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FIG. 5





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FIG. 6

(A) MATERIAL 1

ASPECT RATIO = 506 %



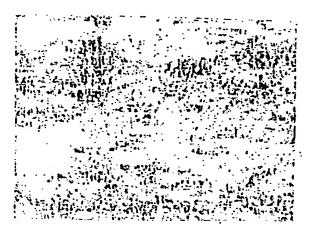
(B) MATERIAL 2

ASPECT RATIO = 347 %



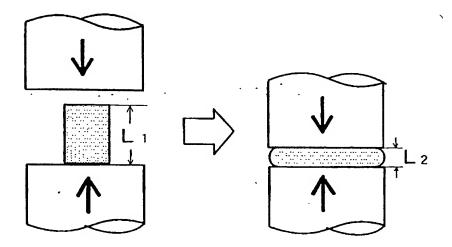
(C) MATERIAL 3

ASPECT RATIO = 300 %



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FIG. 8



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FIG. 9

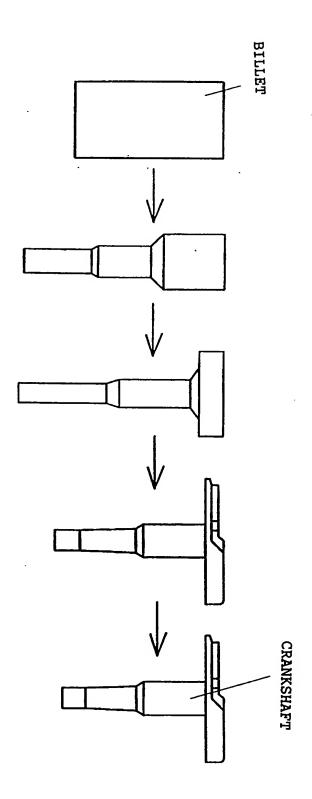


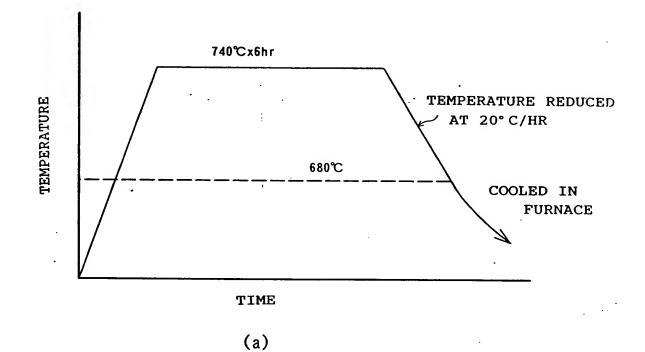
FIG. 10

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Phone No.: (612) 336-4722
Sheet 10 of 42 HEATING FURNACE ROLLING MACHINE BLANK 4: CUTTING SHEAR DEVICE COOLING WINDER <u>@</u> SURFACE - HARDENED MATERIAL ROD œ •• MATERIAL COIL 6: COOLING BED ACID PICKLING ACID PICKLING SPHERODIZING ANNEALING

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FIG. 11



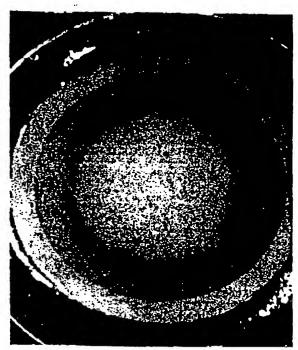


750℃x4hr 735℃x3.5hr TEMPERATURE TEMPERATURE REDUCED AT 15°C/HR ℃089 COOLED IN FURNACE TIME

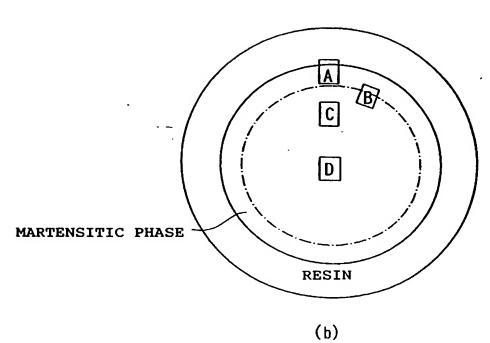
(b)

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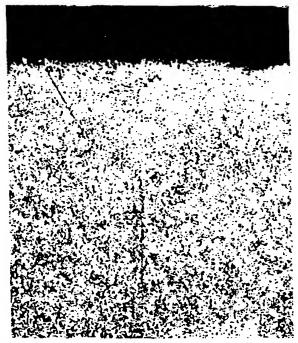


MARTENSITIC MATERIAL (a) PRIOR TO SPHERODIZING ANNEALING × 2. 1



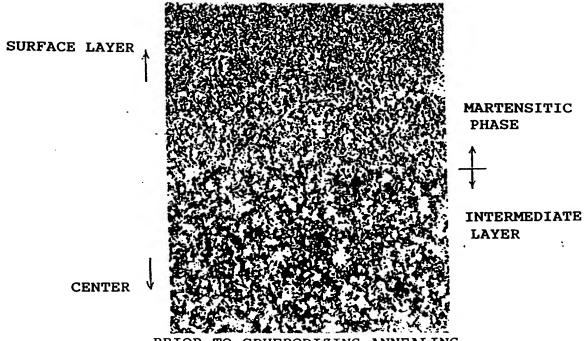
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PRIOR TO SPHERODIZING ANNEALING SURFACE LAYER × 100

FIG. 14



PRIOR TO SPHERODIZING ANNEALING SURFACE LAYER AND INTERMEDIATE LAYER × 200

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FIG. 15



PRIOR TO SPHERODIZING ANNEALING 1/2 R PART × 400

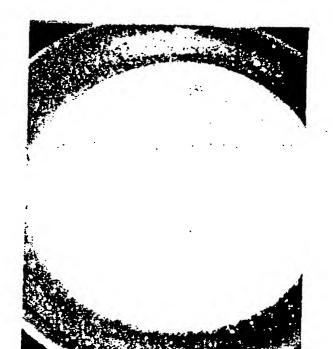


PRIOR TO SPHERODIZING ANNEALING CENTRAL PART × 400

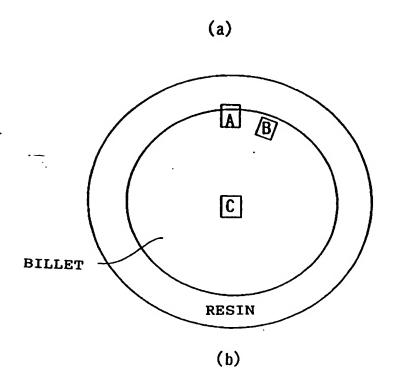
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FIG. 17



MARTENSITIC MATERIAL
AFTER SPHERODIZING ANNEALING PATTERN 1
× 2. 1



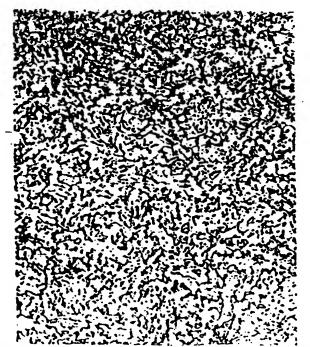
Inventor: Ando, et al
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FIG. 18



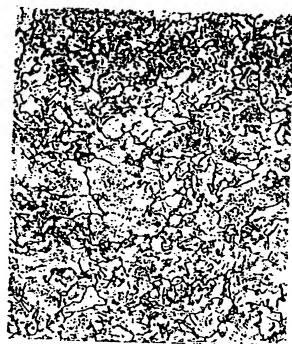
AFTER SPHERODIZING ANNEALING PATTERN 1 SURFACE LAYER × 100

FIG. 19



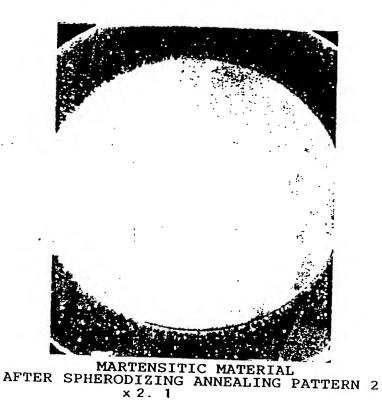
AFTER SPHERODIZING ANNEALING PATTERN 1 SURFACE LAYER × 400

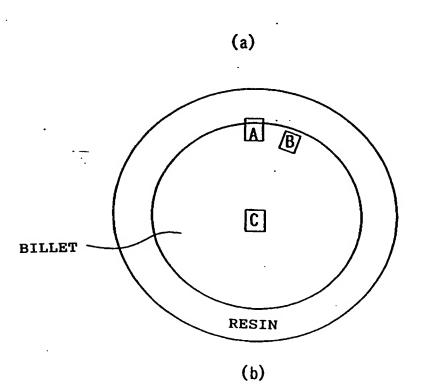
Inventor: Ando, et al
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AFTER SPHERODIZING ANNEALING PATTERN 1 1/2 R PART \times 400

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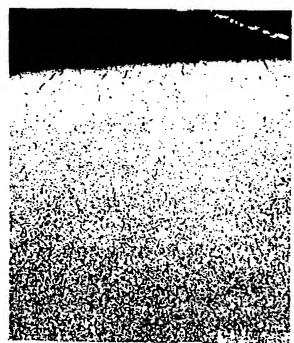




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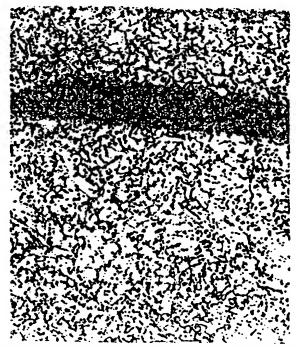
OF COLD-FORGING

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AFTER SPHERODIZING ANNEALING PATTERN 2 SURFACE LAYER × 100

FIG. 23



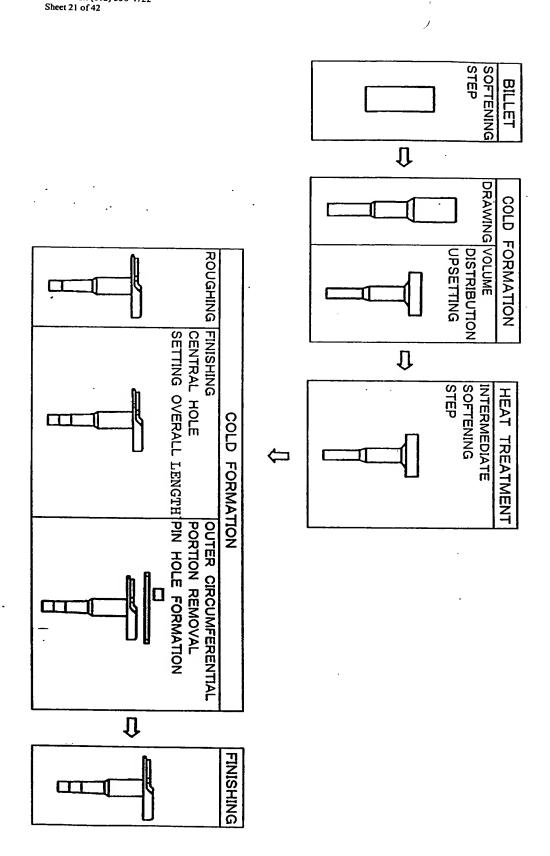
AFTER SPHERODIZING ANNEALING PATTERN 2 SURFACE LAYER × 400

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AFTER SPHERODIZING ANNEALING PATTERN 2 1/2 R PART \times 400

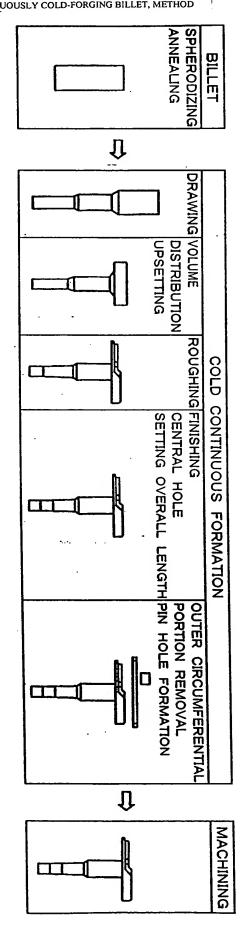
Inventor: Ando, et al
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FIG. 27

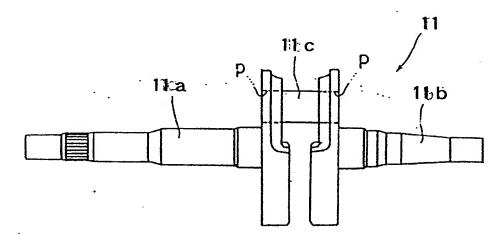
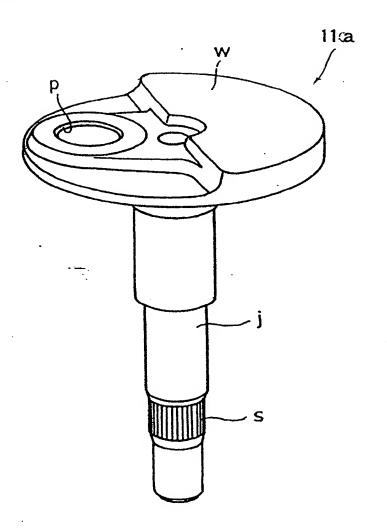
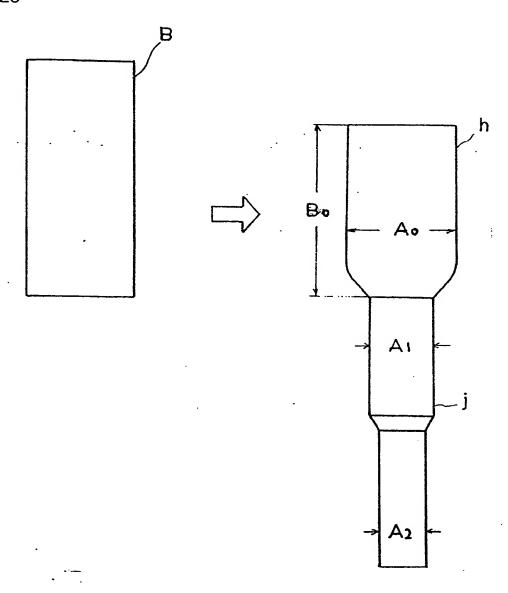


FIG. 28



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FIG. 29

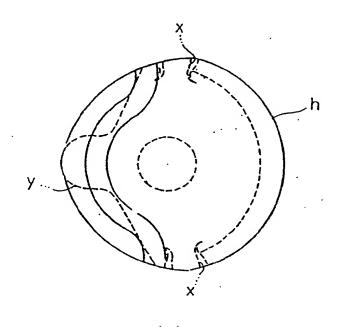


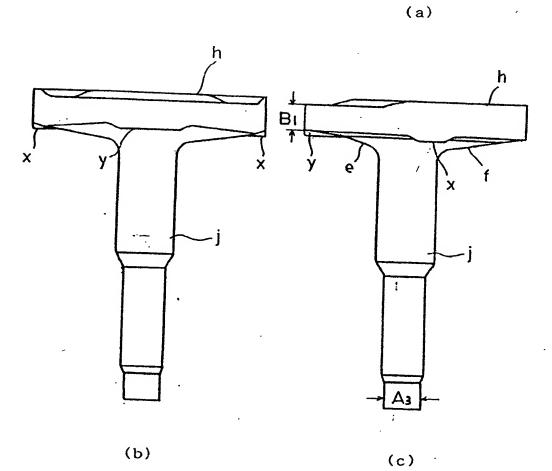
(a)

(b)

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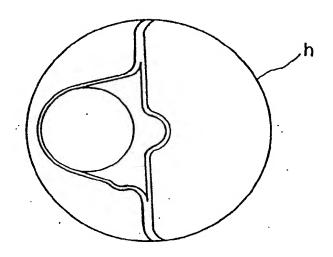
FIG. 30

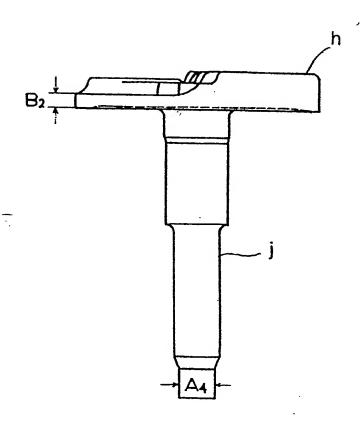




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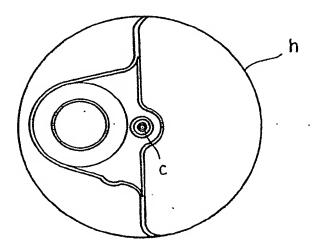
FIG. 31

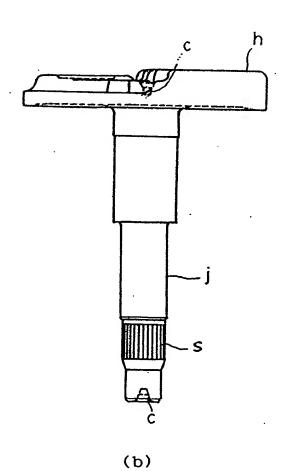




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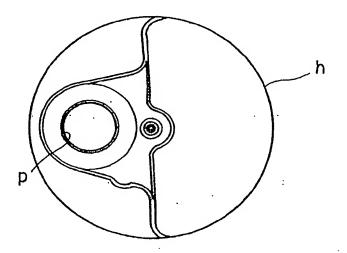
FIG. 32

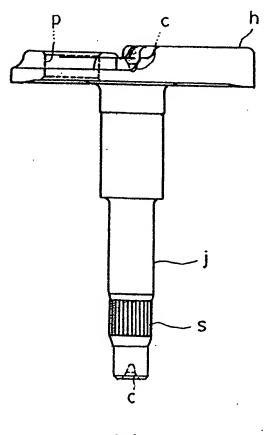




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FIG. 33

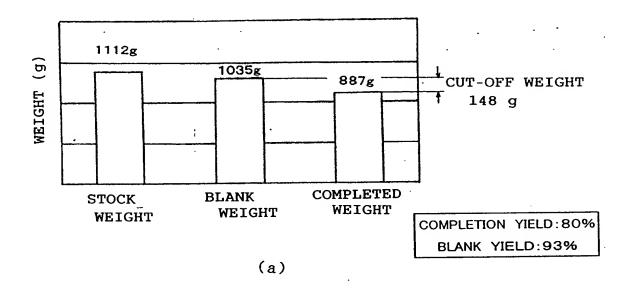




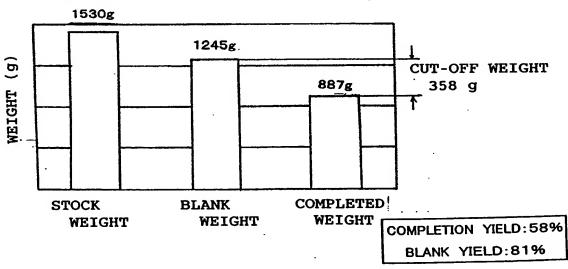
Inventor: Ando, et al
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FIG. 34

(INVENTIVE COLD-FORGING METHOD)

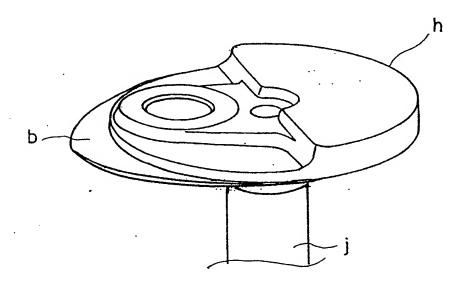


(CONVENTIONAL COLD-FORGING METHOD)



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FIG. 35

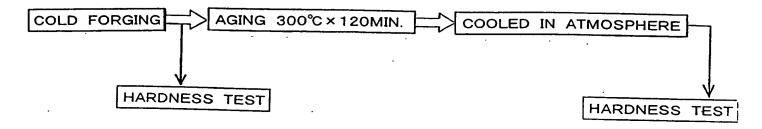


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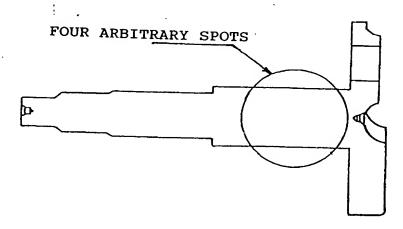
OF COLD-FORGING

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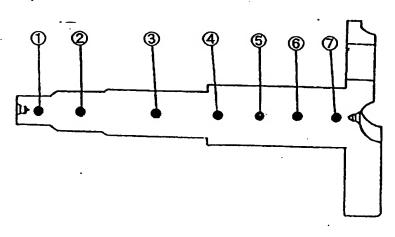
FIG. 36



(a)



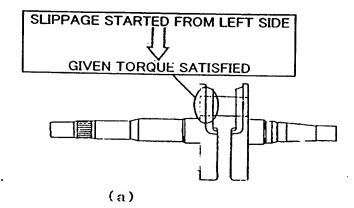
(b)



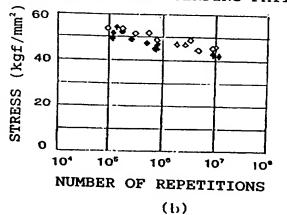
Inventor: Ando, et al
Docket No.: 12052.33USD2
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FIG. 37

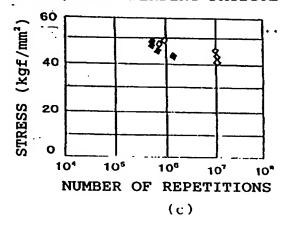
SLIP TORQUE



S - N CURVE (ROTATIONAL BENDING FATIGUE TEST)

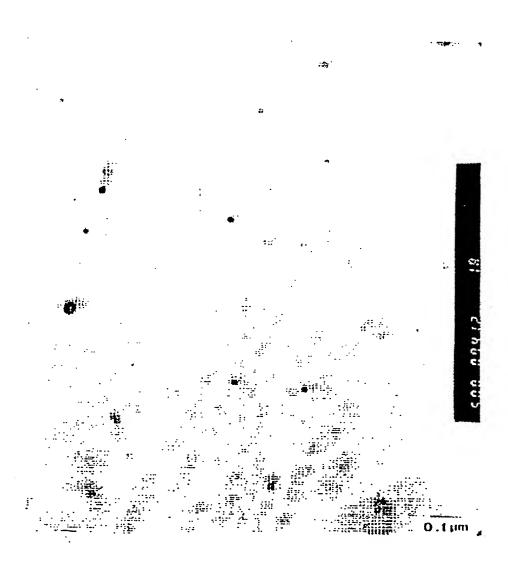


S - N CURVE (SOLID BENDING FATIGUE TEST)



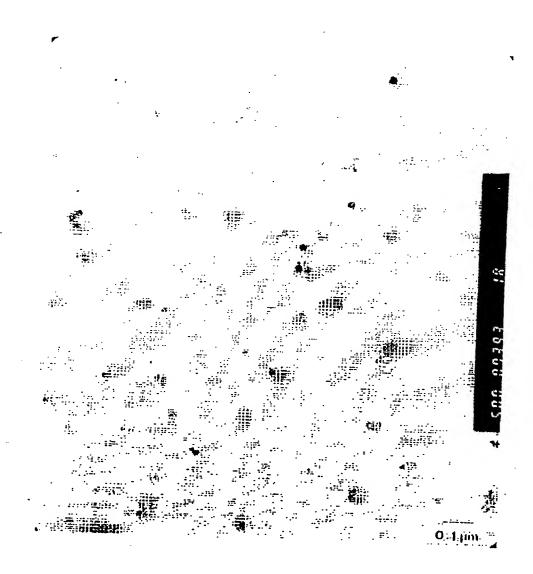
Inventor: Ando, et al
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FIG. 38



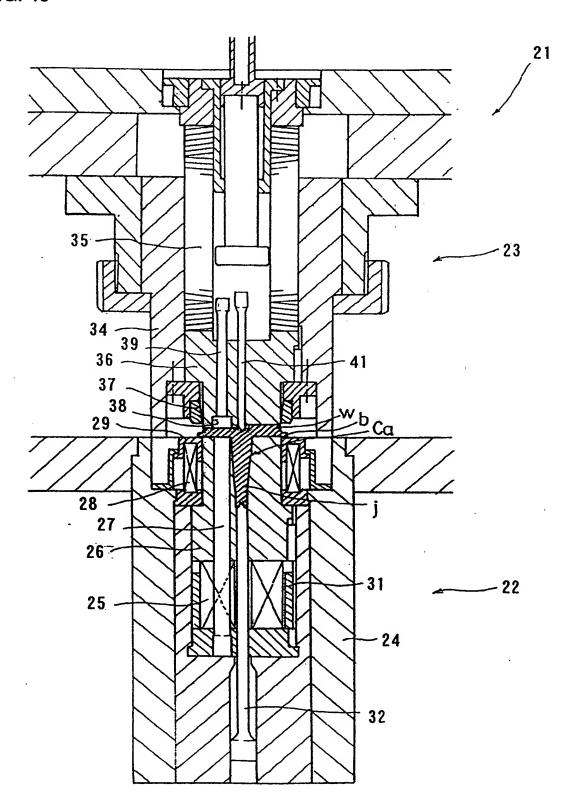
Inventor: Ando, et al
Docket No.: 12052.33USD2
Title: BILLET FOR COLD FORGING, METHOD OF MANUFACTURING BILLET FOR
COLD FORGING, METHOD OF CONTINUOUSLY COLD-FORGING BILLET, METHOD
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FIG. 39



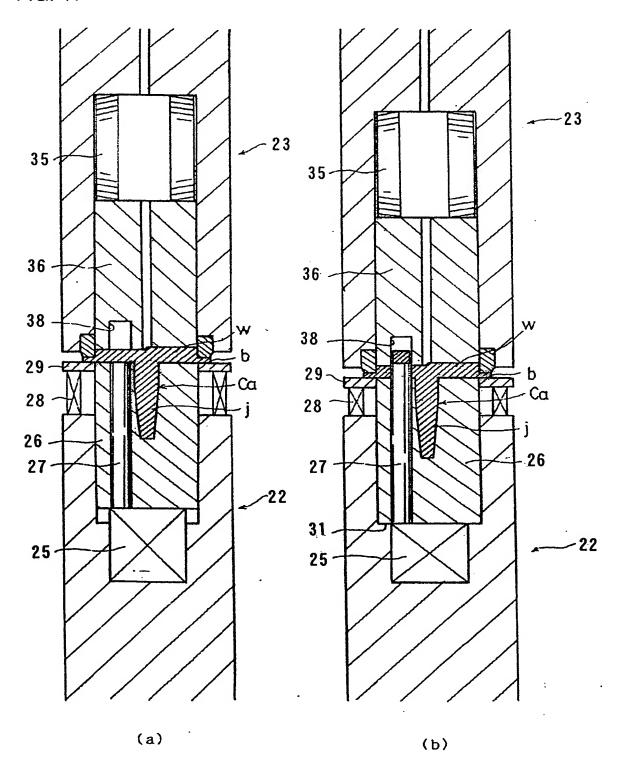
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FIG. 40



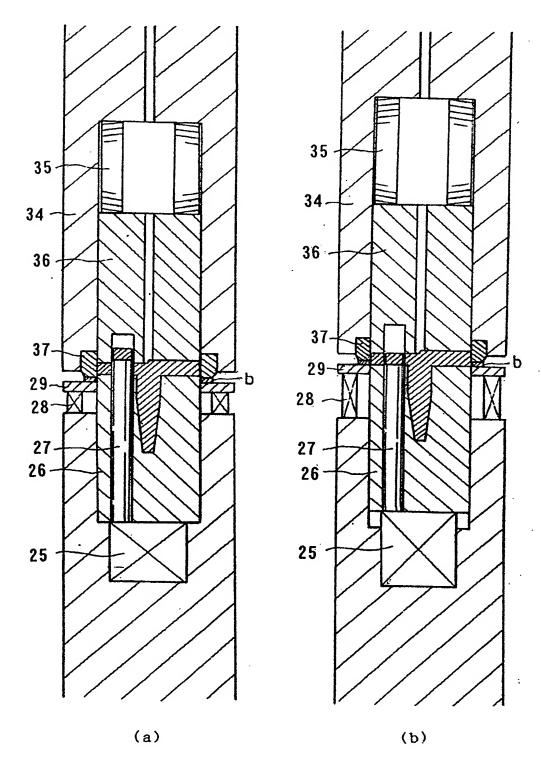
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FIG. 41



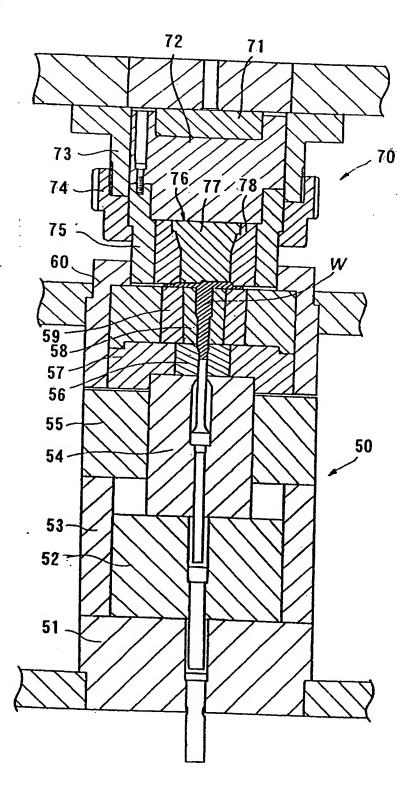
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FIG. 42



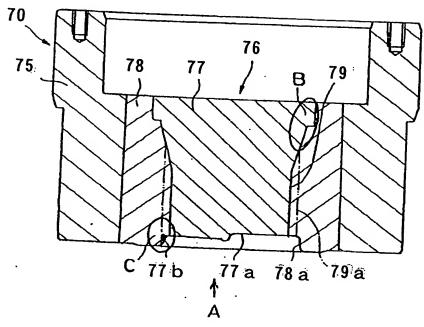
Inventor: Ando, et al
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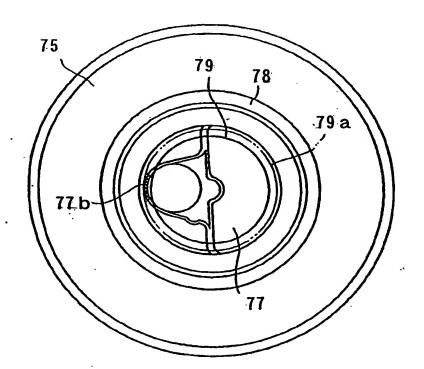
FIG. 43



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FIG. 44





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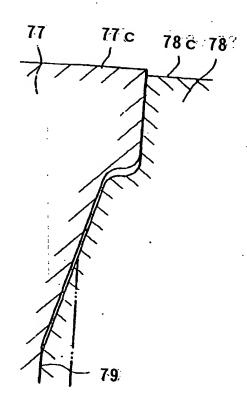
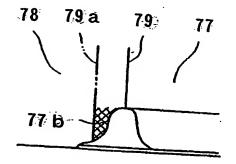


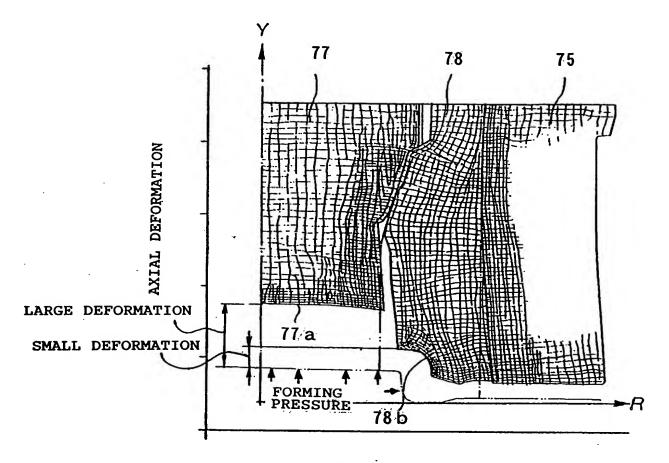
FIG. 47



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FIG. 48



RADIAL POSITION

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FIG. 49

	Billet manufacturing process					Aspect ratio	Crack
	Spherodizing annealing prio to drawing		Cutting	Spherodizing	Shot bonderizing	of carbide	percentage % N=100
Material 1	None	None	0	0	0	506	35%
Material 2	None	(20%) O	0	0	0	347	5%
Material 3	0	(20%) O	0	0	0	300	0%

Aspect ratio (%) = $b/a \times 100$

